IN THE ABSTRACT:

Please cancel the current abstract and insert the following. A marked-up copy showing the changes made to the abstract is attached hereto in Appendix A.

-- A projection exposure apparatus includes an illumination optical system for illuminating a pattern of a reticle with laser light from a continuous emission excimer laser, a projection optical system for projecting the illuminated pattern onto a substrate, and an adjusting device for adjusting an optical characteristic of the projection optical system in accordance with a change in wavelength of the laser. --

IN THE SPECIFICATION:

Please amend the specification as follows:

Please substitute the paragraph beginning at page 1, line 5, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- This invention relates to a projection exposure apparatus and a device manufacturing method using the same. More particularly, the invention concerns a projection exposure apparatus and a device manufacturing method which are suitably usable in a projection exposure step in a photolithographic process, specifically for the manufacture of semiconductor devices such as ICs or LSIs, image pickup devices such as CCDs, display devices such as liquid crystal panels, and magnetic head devices, for example. In the present invention, a continuous emission

excimer laser may be used as a light source for transferring a pattern of a reticle onto a photosensitive substrate. --

Please substitute the paragraph beginning at page 1, line 19, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- A continuous emission excimer laser can be used as a light source in the manufacture of semiconductor devices or other devices such as liquid crystal panels, for example, based on the photolithographic technology (Japanese Laid-Open Patent Application, Laid-Open No. 163547/1998). --

Please substitute the paragraph beginning at page 1, line 25, and ending on page 2, line 6, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- The aforementioned Japanese patent application document discloses the use of an incoherency transforming system in which speckle patterns are removed by use of a rotary diffusion plate provided in an illumination optical system for illuminating a reticle. However, this document does not specifically refer to how to construct a projection optical system for projecting the circuit pattern of the reticle. --

Please substitute the paragraph beginning at page 2, line 27, and ending on page 3, line 7, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- It is accordingly an object of the present invention to provide a projection exposure apparatus and a device manufacturing method, by which a pattern of a reticle can be projected on a substrate very accurately even when a continuous emission excimer laser is used as a light source and even when a monochromatic lens is used as a projection optical system. --

Please substitute the paragraph beginning at page 4, line 7, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- BRIEF DESCRIPTION OF THE DRAWINGS --

Please substitute the paragraph beginning at page 5, line 24, and ending on page 6, line 5, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- Figure 1 is a schematic view of a projection exposure apparatus according to a first embodiment of the present invention. In this embodiment, the invention is applied to a step-and-scan type scanning projection exposure apparatus having a resolution of 0.13 micron or less, being usable for the production of various devices such as semiconductor devices, liquid crystal devices, image pickup devices and magnetic heads, for example. --

Please substitute the paragraph beginning at page 6, line 6, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- Denoted in Figure 1 at 1 is an ArF excimer laser of a continuous emission type, having a center wavelength of a wavelength spectrum of 193 nm and a half bandwidth of 0.2 pm or less, preferably, not greater than 0.1 pm. Denoted at 5 is a half mirror (semi-transmission mirror), and denoted at 2 is an illumination optical system for illuminating a reticle Re having a circuit pattern formed thereon, with the use of laser light from the laser 1. Denoted at 3 is a projection optical system for projecting a reduced image of the circuit pattern of the reticle Re, onto a wafer W. The projection optical system 3 is provided by a lens system being made of a substantially single glass material. Denoted at 4 is a movable stage being movable while holding a wafer W thereon. --

Please substitute the paragraph beginning at page 7, line 14, and ending on page 8, line 1, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- Denoted at 8 is a second operation unit which is operable in response to an output of the wavemeter 6, to detect any deviation of the current center wavelength (as represented by that output) from the design wavelength. Also, this operation unit is operable to adjust changes in the optical characteristic of the projection optical system 3 resulting from that deviation. As regards the adjustment, it may be done by moving plural lenses of the projection optical system or the movable stage in the optical axis direction, by changing the pressure of a closed space between

adjacent lenses, or by injecting a gas having a refractive index different from that of the air, into a closed space between adjacent lenses, for example. --

Please substitute the paragraph beginning at page 8, line 2, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- With this procedure, in the projection optical system 3, which is a monochromatic lens system, any variation in optical characteristics such as magnification, focal point position and aberration, for example, due to changes in wavelength of the laser light can be avoided. Therefore, a circuit pattern of a reticle Re can be projected onto a wafer W very accurately. --

Please substitute the paragraph beginning at page 10, line 13, and ending on page 11, line 1, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- In Figure 3, a laser light beam from the excimer laser 1 (Figure 1) is divided by a polarization control system 21 into at least two light beams. If it is bisected, for example, the laser beam may be divided into two light beams having mutually orthogonal polarization directions. Laser light which consists of these two light beams, being combined, is received by a sectional intensity distribution uniforming system 22 by which the sectional intensity distribution of the laser light is made uniform. The sectional intensity distribution uniforming system may include at least one of a combination of a fly's eye lens and a lens, and an optical pipe

(kaleidoscope). Also, the polarization control system 21 may include a polarization beam splitter for dividing light, for example. --

Please substitute the paragraph beginning at page 11, line 2, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- Laser light from the sectional intensity distribution uniforming system 22 is focused by a scanning optical system 23 upon a pupil plate of the illumination optical system 2, and a light spot is produced there. Then, one or two galvano mirrors of the scanning optical system 23, provided for two-dimensional scanning, are actuated and rotated by a driving unit 24, by which the laser light spot is scanningly moved. As a result of this, a secondary light source (effective light source) having a predetermined shape and size is produced on the pupil plane. The thus produced secondary light source may have a circular shape, a ring-like zone shape having a finite width, or a quadrupole shape, for example. The shape may be chosen automatically or manually in accordance with the type or size of the pattern of the reticle Re. The laser light from the scanning optical system 23 goes through a masking blade imaging system 25, and it impinges on the reticle (not shown). Consequently, the reticle is illuminated with slit-like light having a rectangular or arcuate sectional shape as described above. --

Please substitute the paragraph beginning at page 12, line 20, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- Figure 4A illustrates galvano mirrors GM1 and GM2, in an example in which the scanning optical system 23 has two galvano mirrors. --

Please substitute the paragraph beginning at page 12, line 23, and ending on page 13, line 9, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- In Figure 4A, the galvano mirror GM1 can oscillate in a direction along the sheet of the drawing, as depicted by an arrow, while the galvano mirror GM2 can oscillate in a direction perpendicular to the sheet of the drawing. By these rotational motions, a parallel light beam LLa being parallel to the optical axis is reflectively deflected, and the deflection light is outputted as a parallel light beam, which then goes through a condensing lens system (not shown). With this arrangement, the pupil plane of the illumination optical system is scanned two-dimensionally by a light spot, such that a secondary light source (effective light source) of a desired shape is produced there. --

Please substitute the paragraph beginning at page 13, line 15, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- Figure 4B illustrates a galvano mirror GM3, in an example wherein the scanning optical system includes a single galvano mirror. In Figure 4B, the galvano mirror GM3 can oscillate in a direction along the sheet of the drawing and also in a direction perpendicular to the sheet of the drawing, to reflectively deflect a light beam LLa incident thereon. Thus, through a

condensing lens system (not shown), the pupil plane of the illumination optical system is scanned two-dimensionally, such that a secondary light source (effective light source) is produced there. --

Please substitute the paragraph beginning at page 13, line 26, and ending on page 14, line 2, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- Figures 5A - 5D are schematic views each illustrating a secondary light source produced on the pupil plane of the illumination optical system by means of the scanning optical system 23. --

Please substitute the paragraph beginning at page 16, line 18, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- Denoted at 123 is a movement control system which serves to move, in cooperation with a driving unit (not shown), the reticle 120 and the semiconductor substrate (wafer) 122 in directions of arrows, at the same ratio as the magnification of the projection optical system 121 and exactly at constant speeds. --

Please substitute the paragraph beginning at page 22, line 12, and ending on page 23, line 6, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- The seventh lens group L7 comprises, in an order from the object side, (i) a positive lens of a meniscus shape and having a convex surface facing to the image side, (ii) a positive lens with an aspherical surface and having a biconvex shape, (iii) a positive lens of an approximately flat-convex shape and having a convex surface facing to the object side, (iv) two positive lenses of a meniscus shape and having a convex surface facing to the object side, (v) a negative lens of a meniscus shape and having a concave surface facing to the image side, and (vi) a positive lens of a meniscus shape and having a convex surface facing to the object side. In this seventh lens group L7, the aspherical surface where an axial light flux, which is a light flux emitted from the axis upon the object surface is used at a higher position, serves mainly to correct a negative spherical aberration to be produced by the seventh lens group that has a strong positive refracting power. Also, the aspherical surface used at the convex surface adjacent to the image plane, is contributable mainly to assure well-balanced correction of the coma and distortion. --

Please substitute the paragraph beginning at page 24, line 16, and ending on page 25, line 2, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- In Figure 9, those elements corresponding to the components of the projection exposure apparatus of Figure 1 are denoted by similar reference numerals and characters, and a description thereof is omitted. The projection exposure apparatus of Figure 9 differs from that shown in Figure 1, mainly in that it is provided with a mechanism for injecting pulse light, as produced by a pulse emission ArF excimer laser 201 having a center wavelength 193 nm and a half bandwidth

not greater than 1 pm, into the continuous emission excimer laser 1, such that the emission wavelength of the continuous excimer laser 1 can be held at the emission wavelength of the pulse light. This procedure is called injection locking. --

Please substitute the paragraph beginning at page 25, line 3, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- In continuous emission excimer lasers, in some cases, it takes a substantial time until, after a start of the emission, the emission wavelength becomes equal to a design value (usually, the same as the wavelength with respect to which an optical system is designed) or alternatively, in worst cases, the emission wavelength does not come to the design value. If, on the other hand, in accordance with the injection locking method, the pulse emission excimer laser light having an emission wavelength the same as the design wavelength thereof and having its bandwidth narrowed to 1 pm or less is injected into a continuous excimer laser, the emission wavelength of the continuous emission excimer laser can be held at the design wavelength of 193 nm thereof, just from a start of the emission. --

Please substitute the paragraph beginning at page 25, line 19, and ending on page 26, line 15, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- A portion of the laser light outputted from the pulse emission excimer laser 201 is reflected by a semi-transmission mirror 203, and it enters a wavelength monitor 204. The

wavelength monitor 204 serves to detect the wavelength of the pulse laser light, and it applies the detection result to an operation unit 202. On the basis of the output of the wavelength monitor 204, the operation unit 202 detects the amount of any deviation of the current center wavelength of the pulse laser light, from the design wavelength. Also, on the basis of the thus detected deviation, the operation unit 202 actuates a band-narrowing element inside the pulse emission excimer laser 201 (for example, it may be a prism, a diffraction grating or an etalon), so as to assure that the center wavelength of the pulse emission excimer laser 201 becomes equal to the design wavelength 193 nm. As a result of this, the pulse laser light whose center wavelength is held at 193 nm can be injected into the continuous emission excimer laser 1. With this procedure, the emission wavelength of the continuous emission excimer laser 1 can be held at the design wavelength of 193 nm just from the start of emission. --

Please substitute the paragraph beginning at page 26, line 16, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- After this, the pulse laser light is continuously injected into the continuous emission excimer laser 1 in accordance with the injection locking method, by which the center wavelength of the laser light outputted from the continuous emission excimer laser 1 can be adjusted and maintained substantially constant. Here, as will be described later, wavelength stabilization means may be applied to the continuous emission excimer laser 1 and, on that occasion, the injection locking may be discontinued once the pulse laser is injected. --

Please substitute the paragraph beginning at page 27, line 8, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- In accordance with this embodiment, in the projection optical system 3, which is a monochromatic lens system, any variation in the optical characteristics thereof such as magnification, focal point position or aberration, for example, due to changes in wavelength of the laser light from the continuous emission excimer laser 1, can be avoided. As a result, a circuit pattern of a reticle can be projected on a wafer W very accurately. --

Please substitute the paragraph beginning at page 27, line 17, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- In accordance with this embodiment of the present invention, a projection exposure apparatus, by which a pattern image of a resolution not broader than 0.09 micron is attainable, is accomplished. --

Please substitute the paragraph beginning at page 27, line 21, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- In this case, the excimer laser 1 may be a continuous emission $F_2$ excimer laser having a center wavelength of 157 nm, and a half bandwidth of 0.1 pm or less, preferably, and not greater than 0.08 pm. --

Please substitute the paragraph beginning at page 28, line 1, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- The projection exposure apparatus of Figure 10 differs from that shown in Figure 1 in that: although the second operation unit 8 operates on the basis of a signal from the wavemeter 6 to adjust a change in optical characteristic of the projection optical system caused by failure of holding the wavelength from the excimer laser 1 at the design wavelength, in a similar manner as in the embodiment of Figure 1, if the adjustment is incomplete, the wavelength from the laser 1 is adjusted by means of the first operation unit 7. --

Please substitute the paragraph beginning at page 28, line 18, and ending on page 29, line 13, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- The first operation unit 7 is operable in response to an output of the wavemeter 6, to detect any deviation of the current center wavelength (as represented by that output) from the design wavelength. Also, the first operation unit 7 is operable to actuate a piezoelectric device 9 on the basis of the detected deviation amount. The wavelength monitor 6, the first operation unit 7 and the piezoelectric device 9 are components of the wavelength stabilization mechanism for stabilizing the emission wavelength of the laser 1. By means of the first operation unit 7 and the piezoelectric device 9, a mirror for resonance of the laser 1 can be minutely oscillated in the optical axis direction to change the resonator length, by which the wavelength of the laser 1 can be adjusted. With this procedure and together with the second operation unit 8, in the projection

optical system 3, which is a monochromatic lens system, any variation in optical characteristics such as magnification, focal point position and aberration, for example, due to changes in wavelength of the laser light can be avoided. Therefore, a circuit pattern of a reticle Re can be projected onto a wafer W very accurately. --

Please substitute the paragraph beginning at page 29, line 14, and ending on page 30, line 2, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- The wavelength stabilization mechanism including wavemeter 6, operation unit 7 and piezoelectric device 9, for example, may be applied to the second embodiment shown in Figure 6. On that occasion, the wavelength stabilization mechanism may be operated during injection of laser light. This enables that the center wavelength of the continuous emission excimer laser can be quickly held at the design wavelength. After this, the injection locking may be discontinued, unless the continuous emission excimer laser is restarted. This is because even if the injection locking is discontinued, as long as the wavelength stabilization mechanism is held in operation, the center wavelength of the laser light outputted from the continuous emission excimer laser can be maintained constant. --

Please substitute the paragraph beginning at page 30, line 6, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- Further, the present invention is applicable also to a step-and-repeat type projection exposure apparatus for the manufacture of various devices such as semiconductor devices, liquid crystal devices, image pickup devices, or magnetic heads, for example. --

Please substitute the paragraph beginning at page 30, line 14, and ending on page 31, line 8, with the following. A marked-up copy of this paragraph, showing the changes made thereto, is attached in Appendix A.

-- Figure 11 is a flow chart for explaining the procedure for manufacturing various microdevices such as semiconductor chips (e.g., ICs or LSIs), liquid crystal panels, or CCDs, for example. Step 1 is a design process for designing a circuit of a semiconductor device. Step 2 is a process for making a mask on the basis of the circuit pattern design. Step 3 is a process for preparing a wafer by using a material such as silicon. Step 4 is a wafer process which is called a pre-process wherein, by using the thus prepared mask and wafer, a circuit is formed on the wafer in practice, in accordance with lithography. Step 5 subsequent to this is an assembling step which is called a post-process wherein the wafer having been processed at step 4 is formed into semiconductor chips. This step includes an assembling (dicing and bonding) process and a packaging (chip sealing) process. Step 6 is an inspection step wherein an operation check, a durability check, and so on, for the semiconductor devices produced by step 5, are carried out. With these processes, semiconductor devices are produced, and they are shipped (step 7). --